SMALL-ANGLED, SPECIFICALLY-POSITIONED AND SPECIFICALLY-ORIENTATED LIGHT EMITTING DEVICE OF BACKLIGHT MODULE OF LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention pertains to a kind of LCD backlight module which emitting light beams nonuniformly from specified positions, with each emitted light beam limited to small angle range, and with orientations of said angle range of each emitted beam including orientation pointing to specified opening of LCD substrate or with such and vertical to emitting face of light guiding plate, and with distance of central line of neighboring emitted light beams nearing distance of neighboring LCD substrate openings, and with no light being emitted between two neighboring emitted light beams.

DESCRIPTION OF RELATED ART

The prior arts of backlight module mainly focus on emitting light evenly; As shown in US PATENT published No.6356391, however it is formed by prism arrays also, its aim is to get light emitting of continuous and entire evenness.

Further, as shown in US PATENT published No.5917664, while it is formed by prism arrays also, its aim is to avoid sudden change of brightness when across certain angle during changing viewing-angle.

Technological thought of small-angled, specifically-positioned and specifically-orientated light emitting device of backlight module of liquid crystal display of the present invention is distinct from those prior arts.

As illustrated in Part1 and Part2 of Fig.8, "light guiding plate having multi-focused reflecting patterns" of TAIWAN PATENT published No.463957 has a plurality of multi-focused reflecting patterns on opposite face of emitting face of light guiding plate. Each pattern has a round surface at center, with a plurality of annular round surfaces being concentric from said round surface. Incident light is reflected, by each pattern on LGP, upwards to form plane-type light source. This prior art is that brightness of plane-type light source is made evenly distributed by multi-directioned reflection of multi-focused reflecting mirrors. Technological thought of the present invention is distinct from this prior art.

As illustrated in Part1 and Part2 of Fig.9, "plane-type light source" of TAIWAN PATENT published No.538285 utilizes multi-direction refraction of concave lenses11n or convex lenses11p to make emitting face near lateral incident face have enough brightness.

As illustrated in Part1 and Part2 of Fig.10, and Part1 and Part2 of Fig.11, this prior art also has variant distribution concentration of concave mirrors12p or convex mirrors12n on opposite face of LGP's emitting face and lateral faces except incident face.

By the way of multi-direction of concave and convex mirrors' reflection and higher concentration of reflecting mirrors in periphery of LGP h where brightness is apt to be insufficient, it is possible to achieve evenness of brightness and direction of emitting of plane-type light source. The technological thought of the present invention is distinct from this prior art.

As illustrated in Fig.12, "LCD having localized-light-transmitting backlight" of TAIWAN PATENT published No.560621 has a plurality of light passages52 in reflecting layer51 on the bottom of LCD f, and has a micro-prisms-arrayed optical film g possessing light-focusing portions61 corresponding to light passages52, between LCD f and LGP h. The artificial light L5, after being concentrated, transmits through light passages52 in reflecting layer51, and into LCD f. The total output comes from combined effects of highly reflected natural light L4 from reflecting layer51 and artificial light L5 enhanced by micro-prism-arrayed optical film g, with enhanced total light output of LCD.

The stronger function of light-focusing portions61, the more artificial light L5 transmitting through light passages52, and the less proportion of area occupied by light passages52, and therefore the larger proportion of area used to reflect, and then more reflected natural light L4 can be

used. According to this design, light output of LCD f can be promoted, and contrast of LCD f to natural light L4 can be increased.

This prior art is characterized in reflecting layer51 possessing light passages52 and micro-prisms-arrayed optical film g possessing light-focusing portions61.

Although it would make emitted artificial light L5 point to specified positions according to its claims' declaration, the critical structure of micro-prisms-arrayed optical film g possessing light-focusing portions61 and corresponding parameters thereof are not disclosed at all.

According to specification and drawings of this prior art, its micro-prisms-arrayed optical film g is independent from LGP. The macrostructure of this prior art is different from that of the present invention which has a plurality of lower prisms engaged together with LGP and an independent upper prism plate possessing a plurality of upper prisms.

Most important of all, the present invention discloses not only its optical process, but the microstructure also, including its characteristics and its corresponding parameters.

SUMMARY OF THE INVENTION

The aim of the present invention is to solve the problem of conventional backlight module that large amount of energy is wasted in illuminating opaque portion of LCD substrate such as common electrode and black matrix, and to provide a kind of backlight module which emits

light beams nonuniformly from specified positions, with each beam limited to small angle range and pointing to specified opening of LCD substrate.

As illustrated in Fig.1 and Fi.2, the structure of the present invention includes:

Lower prism 1, making light beams propagating in certain angles range inside LGP transmit through its emitting face 7 of lower prism 1;

Light guiding plate 2(LGP), engaged with a plurality of lower prisms 1 into an integral unit on its emitting surface; or produced together, with a plurality of lower prisms 1 located on its emitting surface, in an unit process;

Upper prism 3, making light beams transmitting into its entering face 8 be reflected totally from its total reflecting face 9 and transmit through upper prism plate 4 in certain specified orientations;

Upper prism plate 4, engaged with a plurality of upper prisms 3 into an integral unit; or produced together with a plurality of upper prisms 3 in an unit process.

The cross section of said lower prism1 or said upper prism 3 includes quasi-triangle, and the descriptions and illustrations of the present

invention mentioned below will take lower prism and upper prism having quasi-triangle cross section as representative examples to describe.

As illustrated in Fig.2, the optical process of the present invention is described as follows:

The light beams propagating in certain angles range (with respect to LGP2) inside LGP2 are refracted by each lower prism 1 and transmit through emitting face 7 of each lower prism 1, and across air gap 6; then said light beams are incident on, refracted by and transmit into entering face 8 of corresponding upper prism 3, and said light beams propagate inside upper prism3 and onto total reflecting face 9, and then said light beams are totally reflected from said total reflecting face 9, and further said totally reflected light beams transmit through upper prism plate 4.

The said light beams transmitting through upper prism plate 4 are limited to small angle range, with orientations of said small angle range including pointing to a specified orientation.

In the descriptions and illustrations of the present invention, it is taken as representative example that orientations of said small angle range include one pointing to a specified opening 5 of LCD substrate and vertical to upper prism plate 4.

The said light beams transmitting through upper prism plate 4 can be looked as if emitted from a specified corresponding position on LGP.

In the descriptions and illustrations of the present invention, it is taken as representative example that said light beams transmitting through upper prism

plate 4 can be looked as if those were emitted from nearby of border16 of each two corresponding neighboring lower prisms.

The optical process described above has the following characteristics:

(1) each light beam transmitting through upper prism plate 4 is emitted only from border's nearby of corresponding lower prisms;

(2) each light beam transmitting through upper prism plate 4 is limited to small angle range, with orientations of said small angle range include one pointing to a specified opening 5 of LCD substrate and vertical to upper prism plate 4;

(3) lines, which are drawn from borders of each two neighboring lower prisms and vertical to upper prism plate 4, will transmit through corresponding openings 5 of LCD substrate;

(4) the angle θ_1, formed by incident ray on total reflecting face 11 and normal of total reflecting face 11, is equal to or greater than critical angle θ_c of upper prism 3's material;

(5) width A' of light beam transmitting through upper prism plate 4 is near width A of said light beam before leaving lower prism 1, as illustrated in Fig.4.

To achieve the optical process described above, lower prism 1 and upper prism 3 have to possess the following characteristics and have the following relationships with LGP2, upper prism plate 4 and LCD substrate.

The following corresponding parameters are described with reference to Fig.2 and Fig.3:

(1) the length L of bottom side 10 of quasi-triangle of lower prism 1 (i.e. border line between lower prism1 and LGP2)is similar to distance of neighboring openings 5 of LCD substrate;

(2) lines, which are drawn from borders 16 of each two neighboring lower prisms and vertical to upper prism plate, will transmit through corresponding openings 5 of LCD substrate;

(3) range of opposite angle ω of lower prism 1's emitting face 7 is:

$0 < \omega \leqq 0.5\,\theta_c$,

wherein θ_c is critical angle of lower prism 1's material;

(4) range of angle α formed by emitting face 7 and bottom side 10 of lower prism 1 is:

$0 < \alpha \leqq 90°$;

(5) range of vertex angle θ of upper prism 3's quasi-triangle, which is near LGP 2, is:

$90° - \theta_c \leqq \theta \leqq 180° - \alpha - \omega$,

wherein θ_c is critical angle of lower prism 1's material; α is angle formed by emitting face 7 and bottom side 10 of lower prism 1, and ω is opposite angle of lower prism 1's emitting face;

(6) range of curvature radius r_1 of upper prism 3's entering face 8 is:

$T < r_1 \leqq \infty$,

wherein T is the shortest distance between LCD reflecting layer and "intersecting point of entering face 8 of upper prism 3 and total reflecting face 9 of upper prism 3";

(7) range of curvature radius r_2 of upper prism 3's total reflecting face is:

$T < r_2 \leqq \infty$,

wherein T is the shortest distance between LCD reflecting layer and "intersecting point of entering –face 8 of upper prism 3 and total reflecting face 9 of upper prism 3";

(8) curvature center of entering face 8 and total reflecting face 9 of upper prism 3 are above the border 12 between upper prism 3 and upper prism plate 4 (i.e. opposite side 12 of vertex angle θ of upper prism 3's quasi-triangle).

As illustrated in Fig.5, when there is an air layer 13, which can not be neglected, between LCD 14 and backlight module, each light beam emitted from upper prism plate 4 into air layer 13 is to have a refractive angle, resulting in that light beam width B becomes larger when reaching LCD 14's substrate. As illustrated in Fig.6, one of methods which solving this problem is to adhere a film with similar refractive index of upper prism 3 or to apply a filling layer with similar refractive index of upper prism 3; As the refractive indexes are similar, light beam width B' is to be smaller than B, when reaching LCD 14's substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 illustrates structure of the present invention.

Fig.2 illustrates optical process of the present invention.

Fig.3 illustrates parameters of the structure of the present invention.

Fig.4 illustrates small angle range of emitted light beam of the present invention.

Fig.5 illustrates effect on light beam width when reaching LCD substrate without film having similar refractive index of upper prism 3.

Fig.6 illustrates effect on light beam width when reaching LCD substrate with film having similar refractive index of upper prism 3.

Fig.7 illustrates parameters involved in embodiments of the present invention.

Fig.8 illustrates representative drawing of "light guiding plate having multi-focused reflecting patterns " of TAIWAN PATENT published No.463957.

Fig.9 illustrates the first representative drawing of "plane-type light source" of TAIWAN PATENT published No.538285.

Fig.10 illustrates the second representative drawing of "plane-type light source" of TAIWAN PATENT published No.538285.

Fig.11 illustrates the third representative drawing of "plane-type light source" of TAIWAN PATENT published No.538285.

Fig.12 illustrates representative drawing of "LCD having localized-light-transmitting backlight" of TAIWAN PATENT published No.560621.

LIST OF REFERENCE NUMERALS

1 lower prism

2 LGP light guiding plate

3 upper prism

4 upper prism plate

5 opening of LCD substrate

6 air gap

7 emitting face of lower prism 1

8 entering face of upper prism 3

9 total reflecting face of upper prism 3

10 interface between lower prism 1 and light guiding plate i.e. bottom side of lower prism1 quasi-triangle

11 normal of total reflecting face of upper prism 3

12 interface between upper prism 3 and upper prism plate4 i.e. opposite side of upper prism 3 quasi-triangle's vertex, which nearing light guiding plate

13 air layer

14 LCD liquid crystal display

15 film or filling refractive index of which similar to upper prism plate

16 border of two neighboring lower prisms

L distance of two neighboring openings of lcd substrate

ω opposite angle of emitting face of lower prism

α angle formed by emitting face 7 and bottom 10 of lower prism 1

θ upper prism quasi- triangle's vertex angle which nearing light guiding plate

θ_c critical angle of material of lower prism or upper prism

θ_1 angle formed by light beam and normal 11 of total reflecting 9

r_1 curvature radius of entering face 8 of upper prism 3

r_2 curvature radius of total reflecting face 9 of upper prism 3

t the shortest distance between LCD reflecting layer and intersecting point of entering (incident) face of upper prism 3 and total reflecting face of upper prism 3

A light beam width inside lower prism 1

A' light beam width when leaving upper prism 3

B light beam width when reaching LCD substrate without film having similar refractive index of upper prism 3

B' light beam width when reaching LCD substrate with film having similar refractive index of upper prism 3–

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT OF THE PRESENT INVENTION

Two embodiments of "small-angled, specifically-positioned and specifically-orientated light emitting device of backlight module of liquid crystal display " of the present invention are described with reference to Fig.7 and Table.1. Those specified numeric values proposed in each embodiment are only some part of the present invention, and the range of the present invention is not limited to those.

n=1.49 , θc=42.2° , light source being quasi-parallel light beams paralleling opposite side of α angle, r1=∞ , r2=∞ , thickness of upper prism plate 4 being 0.7mm, n=refractive index of LGP material, θ_1 being angle formed by incident ray and normal of total reflecting face, A being width of light beam when it inside lower prism 1, A' being width of light beam when it leaving upper prism 3, orientation being angle in which light beam emitted from upper prism plate with respect to upper prism plate

	parameter value						result
embodiment	ω	α	θ	θ_1	A	A'	orientation
1	**10°**	**50°**	**80°**	**50°**	**≈0.035mm**	**≈0.03mm**	**≈90°**
2	**21.1°**	**50°**	**74.5°**	**55.6°**	**≈0.074mm**	**≈0.07mm**	**≈90°**

Table.1

As shown in Table.1, within the range of parameters proposed by the present invention, i.e.:

(1) $0 < \omega \leqq 0.5\theta_c$,

(2) $0 < \alpha \leqq 90°$,

(3) $90° - \theta_c \leqq \theta \leqq 180° - \alpha - \omega$,

(4) $T < r_1 \leqq \infty$,

(5) $T < r_2 \leqq \infty$,

incorporated with relationships of concerned elements and parts, proposed by the present invention, in which both lower prism and upper prism are related to LGP, upper prism plate, openings of LCD substrate, and reflecting layer of LCD, the aim of the present invention: backlight module emitting light beams, from specified positions, limited to small angle range, and pointing to openings of LCD substrate, is accomplished certainly.

The focus of the present invention are that backlight module emits light beams, from specified positions, limited to small angle range, and pointing to openings of LCD substrate, and that the light beam optical process has the said characteristic, and that lower prism and upper prism within said parameters range have said relationships proposed by the present invention with LGP, upper prism plate, openings of LCD substrate, and reflective layer of LCD.

Any individual numeric value derived from spirit of the present

invention by logical reasoning, mathematic calculation, or computer simulation, and any equivalent variation or modification are to be within claims range of the present invention. The embodiments mentioned above are only a portion of the present invention, the claims range of the present invention are not to be limited to those embodiments.